Annual Progress Report

TITLE: Survey for Insect Pests of Potato in the Columbia Basin of Washington

PERSONNEL: Carrie H. Wohleb, Regional Vegetable Crops Specialist, Washington State University, Grant/Adams County Extension, 35 C Street NW, Courthouse, P.O. Box 37, Ephrata, WA 98823, (509) 754-2011 ext. 413, Fax (509) 754-0163, e-mail: cwohleb@wsu.edu; Tim Waters, Regional Vegetable Specialist, Washington State University, Franklin/Benton County Extension, 1016 N. 4th, Pasco, WA 99301, (509) 545-3511, Fax (509) 545-2130, e-mail: twaters@wsu.edu.

REPORTING PERIOD: 2013

ACCOMPLISHMENTS:

We monitored potato fields across the Columbia Basin of Washington and throughout the 2013 growing season to learn about the size and location of important insect pest populations. The survey was directed at four insect pests: beet leafhoppers (BLH), green peach aphids (GPA), potato tuberworm (PTW), and potato psyllids. Additionally, other foliar arthropod pests (thrips, lygus bugs, and spider mites) and beneficial insect predators (big-eyed bugs, damsel bugs, and minute pirate bugs) were observed and reported on when their numbers were significant. Information from the survey provided early warning to potato growers that certain pests had been detected in the region.

Regional Survey Routes: Four survey routes covered areas in the north, west, central, and south Columbia Basin of Washington (Figure 1). The "north" route included fields near Moses Lake, Warden, Othello, and Connell. The "west" route included fields near Ephrata, Royal City, Mattawa, George, and Quincy. The "central" route included fields near the Kahlotus Rd., Pasco, Eltopia, Mesa, Connell, and Basin City. The "south" route included fields near Paterson and Plymouth. Thirty-nine potato fields were selected along these routes. Most of the fields were planted to long-season, russet cultivars and conventional management practices were used. Two fields were under organic management.

Beet Leafhopper, Potato Tuberworm, and Potato Psyllid Trapping: As in previous seasons, we monitored BLH using yellow sticky cards (Alphascents - 5.25 x 3.75 inches) mounted on small stakes about 3 inches above the soil surface. Two traps were located near each potato field on the survey routes, either at the field edge, on a ditch bank, or at the open field corner (away from irrigation). Sticky cards for BLH were collected, replaced, and examined weekly from late April through September. In addition to BLH, the cards were examined for potato psyllids.

Potato tuberworm were monitored by trapping adult male moths using the same system as in prior seasons of the survey. The traps consisted of Trece delta traps with pheromone lures on sticky liners. Pheromone lures were provided by Dr. Peter Landoldt. The lures were replaced every three weeks. The delta traps were hung from PVC pipe stands that suspended them about 12 inches from the ground. One trap was placed near each potato field on the survey routes. The sticky liners for monitoring PTW were collected, replaced, and examined weekly from late April through September.

Traps for monitoring potato psyllids were yellow sticky cards (Alphascents - 5.25 x 3.75 inches) mounted on lathe, located inside potato fields about 10 feet from the edge, and placed just above the plant

canopy. These traps were set up in 14 potato fields along the survey routes and two sentinel plots. The number of traps in each field varied from four to nine, depending on the size of the field and ease of access. The sticky cards for potato psyllids were collected, replaced, and examined each week from late May to vine kill (August or September). Additionally, traps were placed in 17 potato fields being monitored by personnel with the J.R. Simplot Company and in 17 potato fields being monitored by personnel with the Wilbur Ellis Company out of Pasco. They used larger yellow sticky cards (Alphascents), but mounted them as described above. The number of traps in these fields varied from one to four. Sticky cards from these fields were delivered to us weekly so we could assist with psyllid identification. All of the potato psyllids found on sticky cards were placed in vials and sent to Dr. Joe Munyaneza's lab for testing to determine if they were infected with *Candidatus* Liberibacter, a bacterium and the causal agent of zebra chip. The psyllids were later passed on to Dr. Kylie Swisher to verify their haplotype.

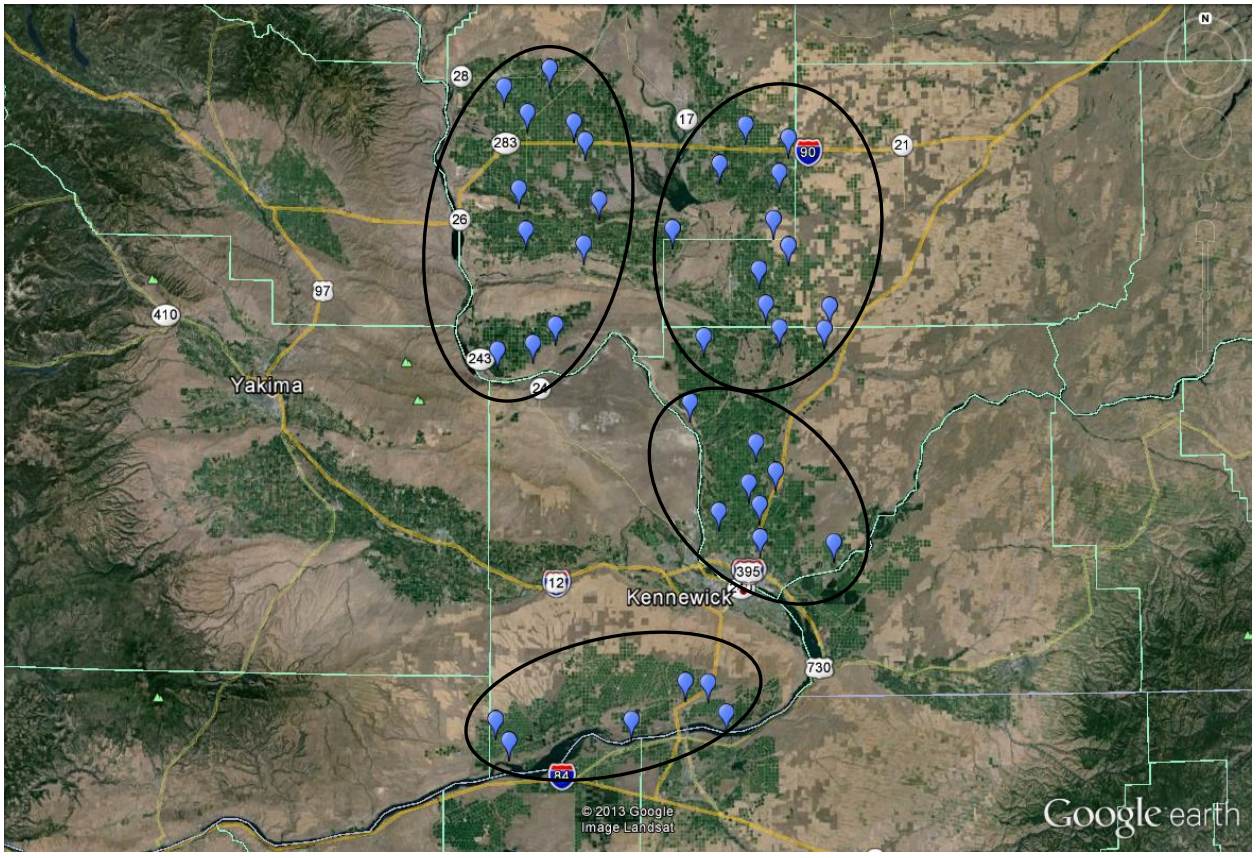


Figure 1. Map showing survey routes and locations of 39 potato fields monitored in 2013.

Aphid Sampling: Aphids were monitored by sampling potato plants using a method established by Dr. Keith Pike in his regional aphid surveys. Potato plants were vigorously shaken over a 5 quart, 8-in diameter collection bucket. This method is particularly effective for monitoring green peach aphids, but is not as effective for quantifying aphid species that do not colonize potatoes. Fifteen or more plants were sampled in each field, and aphid counts were recorded on a per plant basis. Other insects and arthropods observed in the bucket were noted, especially Colorado potato beetles, lygus bugs, thrips, caterpillars,

spider mites, and a number of beneficial insects. Fields were sampled in the same location each week. Sampling was initiated a few weeks after emergence and concluded at vine kill.

Reporting Survey Results: Results of the insect pest survey were reported to the potato industry via weekly emails, a.k.a. "potato pest alerts". The alerts summarized the insect observations each week, and included recommendations for monitoring and managing insect pests and beneficials. The alerts often included photos of insects, feeding damage, or insect-transmitted disease symptoms. The alerts also included web links for more information, including maps showing insect counts at each location, graphs of insect population trends, and management guides. Potato disease reports were included in most of the alerts, especially reports from Dr. Dennis Johnson's late blight hotline. Alerts and other information were archived on the project website at http://www.potatoes.wsu.edu/survey/PotatoInsectSurvey.html. The emails were sent to 579 contacts signed up to receive information related to "potatoes" and "potato pest alerts" through the WSU Irrigated Agriculture Information Service.

RESULTS:

Beet Leafhopper

General Population Trends: Another year of beet leafhopper (BLH) trapping data is helping us learn about population trends for this insect in the Columbia Basin. Figure 2 shows weekly average BLH trap counts in the years from 2007 to 2013, and compares them to the average counts for the seven-year period. The traps (set up in April) typically begin to collect the first BLHs in May. BLH numbers increase rapidly between May and June, with peak populations occurring in late June and early July. The numbers usually drop off significantly in August, but can begin to increase again in September and October. However, there appears to be a lot of variability in the first appearance and size of BLH populations around potato fields each year, so the average trend is not always representative. In 2013, BLH were collected on sticky cards as soon as the traps were set up near potato fields at the end of April. This was much earlier than has been typical. The peak population in 2013 occurred early (early June) and was the largest on record for the seven-year period. After the peak, BLH numbers dropped off to levels that were more typical for the remainder of the season. Interestingly, BLH counts from the previous two seasons (2011-2012) were very small.

Populations Trends in Different Areas in the Basin: It is also apparent from several seasons of trapping that some potato-growing areas in the Columbia Basin maintain larger BLH populations than others. Figure 3 shows weekly average BLH trap counts for different areas in the Columbia Basin; these data are seven-year averages for each area. Mattawa is shown separately from the West Basin, because it tends to be a "hot spot" with some of the largest populations of BLHs throughout the growing season. BLHs show up earlier in Mattawa compared to other areas of the Basin, usually early-mid May. The largest BLH populations near potato fields in Mattawa occur anytime between May and early August, and the numbers tend to remain high through that period, and then drop off. Conversely, the North Basin tends to maintain the smallest numbers of BLHs in the Basin. The traps on the eastern edge of the North Basin (east Moses Lake, Warden, and east Othello) usually record the fewest BLHs each year. On the other hand, the western edge of the North Basin (east Royal Slope) usually has rather large numbers of

BLHs. BLHs usually show up in the North Basin between late May and early June, which is a little later than other parts of the Basin. The largest populations in the North Basin usually occur in early July.

Population Trends for 2013: The BLH season in 2013 got off to a rapid start (Fig. 2). As mentioned above, BLH numbers around potato fields built up rapidly with a peak population in late June (Fig. 2). Figure 4 shows weekly average BLH trap counts for different areas in the Columbia Basin in 2013. In general, the largest BLH numbers were found in Mattawa and in the West Basin. By contrast, the peak population in the North Basin was significantly smaller.

North Basin 2013: Figure 5 shows the average weekly BLH trap counts for the North Basin in 2013 vs. the seven-year average for the area. BLHs in the North Basin showed up earlier compared to previous seasons, and the peak population was larger in 2013 compared to most seasons. In 2013, average trap counts in the North Basin peaked at 13.7 BLHs per card the week of June 4th. The largest number of BLHs found on cards in the North Basin was (63) the week of June 4th on a trap north of Basin City and directly east of Mattawa, and on a trap on the east Royal Slope the week of July 2nd. All other North Basin traps had peak counts ranging from 5 (near Othello) to 52 (east Moses Lake) BLHs per card. The lowest numbers of BLHs were found on cards located to the north and south of Warden.

Mattawa 2013: Figure 6 shows the average weekly BLH trap counts for the Mattawa area in 2013 vs. the six-year average for Mattawa (we did not trap BLH in Mattawa in 2009). Note that the scale of the graph had to be adjusted to accommodate the large counts in May. The Mattawa area was a true "hot spot" for BLHs in 2013. The average trap counts in Mattawa peaked at 137.7 BLHs per card the week of May 6th. The largest number of BLHs found on a card in Mattawa in 2012 was (261) the week of May 7th. The other traps in the Mattawa area had similar counts, peaking at 103 and 215 BLHs per card.

West Basin 2013: Figure 7 shows the average weekly BLH trap counts for the West Basin in 2013 vs. the seven-year average for the area. As in other parts of the Basin, BLH numbers around potato fields peaked early in the West Basin. The average trap counts peaked at 48.4 BLHs per card the week of June 4th. The largest number of BLHs trapped on a card in the West Basin in 2013 was (255) the week of May 21st on a trap southwest of Ephrata. Other traps in the West Basin had peak counts of 18 (near George) to 136 (on the Royal Slope) BLHs per card in 2013. We visited potato fields, several dry bean fields, and one coriander seed field that were infected with beet leafhopper-transmitted diseases (BLTVA and/or curly top) in this area in 2013. We suspect that large numbers of BLH present early in the season pose the greatest risk to crops, because many plant species have been demonstrated to be more susceptible to infection when transmission occurs during the earlier phases of plant development, i.e. when they are small.

Central/South Basin 2013: Figure 8 shows the average weekly BLH trap counts for the Central/South Basin in 2013 vs. the seven-year average for the area. Again, the counts peaked in early June. In 2013, the average trap counts in the Central/South Basin peaked at 24.2 BLHs per card the week of June 4th. The largest number of BLHs trapped on a card in the Central/South Basin in 2013 was (126) the week of June 4th on a trap north of Pasco. Other traps in the Central/South Basin had peak counts of 7 (near Mesa) to 108 (near Pasco) BLHs per card in 2013. We also visited a number of potato fields in this area that were infected with BLTVA, i.e. they had purple top disease.

Recommendations: BLH counts were reported in the "potato pest alerts" most weeks during the growing season. The alerts sent in June included guidelines for monitoring BLH and recommendations for their management. We also provided updates when purple top disease was observed in the Basin. The following information was provided on the website… "Beet leafhoppers are important pests because they transmit BLTVA, a phytoplasma that causes purple top disease in potatoes. In the Columbia Basin, the first spring generation of BLH usually migrates towards potato fields in late May and early June, with a peak flight in late June. Yellow sticky traps placed near potato fields are one way to monitor BLH. Information about setting up traps and identifying BLH can be found in the article, "*Beet Leafhopper Monitoring with Yellow Sticky Cards*". Treatment thresholds based on BLH numbers on traps have not been established, but we know that the risk of infection increases as BLH populations become large. If the numbers on traps build up to 40 or more BLH per week, then it is probably time to be concerned. A typical weekly catch during peak BLH activity is 100. Eliminating weed hosts (wild mustards, Russian thistle, kochia) in areas surrounding potato fields is an important cultural management approach for BLH. Potato growers may also select cultivars that are less susceptible to purple top (Ranger, Umatilla, and Norkotah are considered highly susceptible; Russet Burbank is susceptible; and Alturas and Shepody are moderately susceptible). A number of insecticides are labeled for use on potatoes to control leafhoppers. Systemic at-planting insecticides, especially those with longer residual activity applied at the maximum allowed rate, have been shown to provide some early season control of BLH. Results may vary depending on the product used, application rate, soil and environmental conditions, and insect pressure. Foliar insecticides may also be used to control BLH. These are usually applied in May, June, and sometimes July. Insecticides with long residual activity (10-14 days) are preferred. If you apply a non-systemic insecticide, it may be necessary to shorten the application interval during periods of rapid plant growth to ensure adequate plant coverage. Remember to always read and follow instructions on the pesticide label. For more information about managing BLH, visit *IPM Guidelines for Insects and Mites in ID, OR, and WA Potatoes* and the *PNW Insect Management Handbook*."

Figure 2: Beet Leafhopper Population Trends in the Columbia Basin of WA
Weekly Trapping Data from 2007 to 2013 vs. 7-Year Average

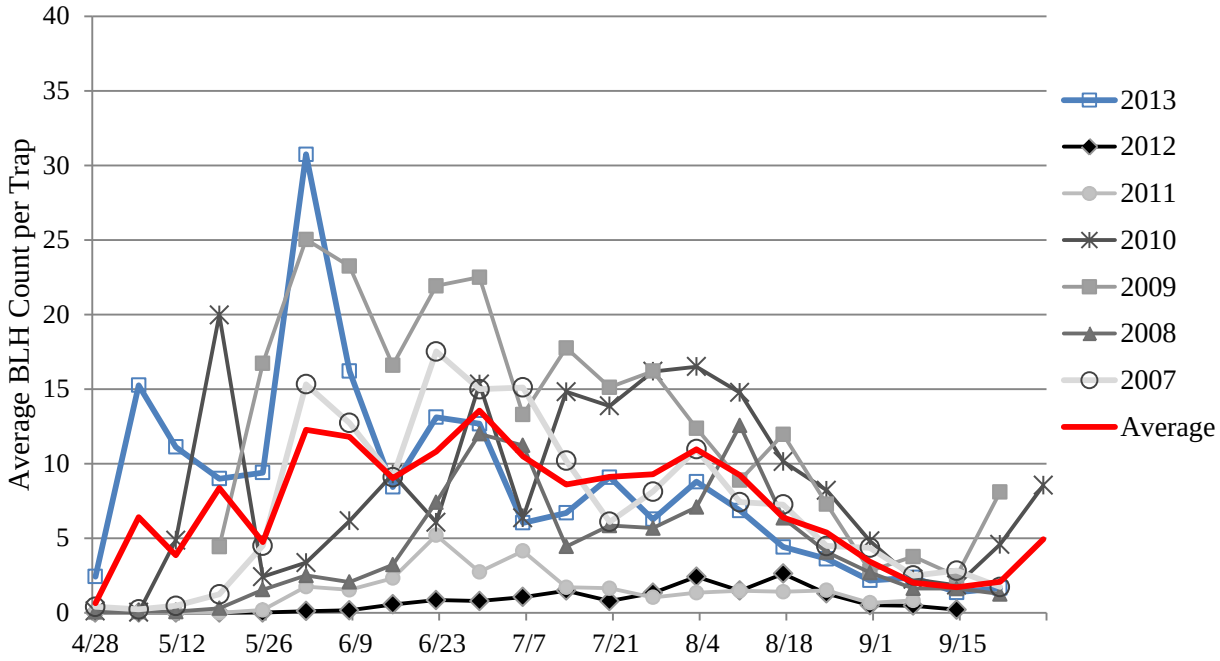


Figure 3. Beet Leafhopper Population Trends in the Columbia Basin of WA
Weekly Trapping Data from Different Areas in the Basin: 7-year Averages

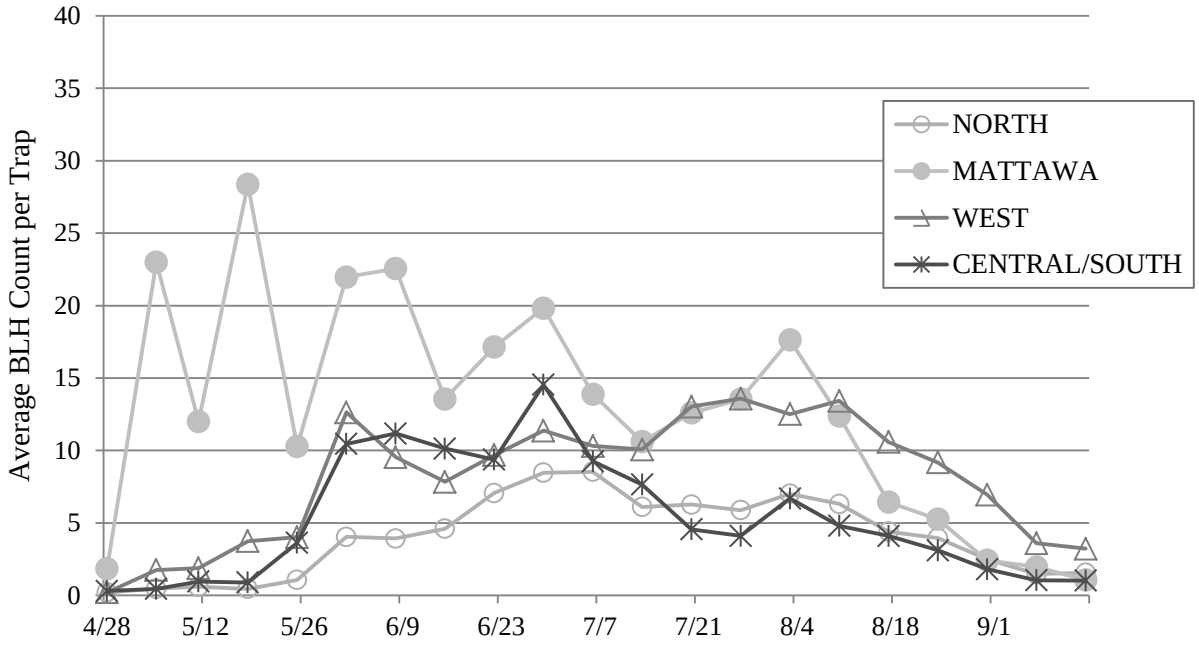


Figure 4. Beet Leafhopper Population Trends in the Columbia Basin of WA
Weekly Trapping Data from Different Areas in the Basin: 2013

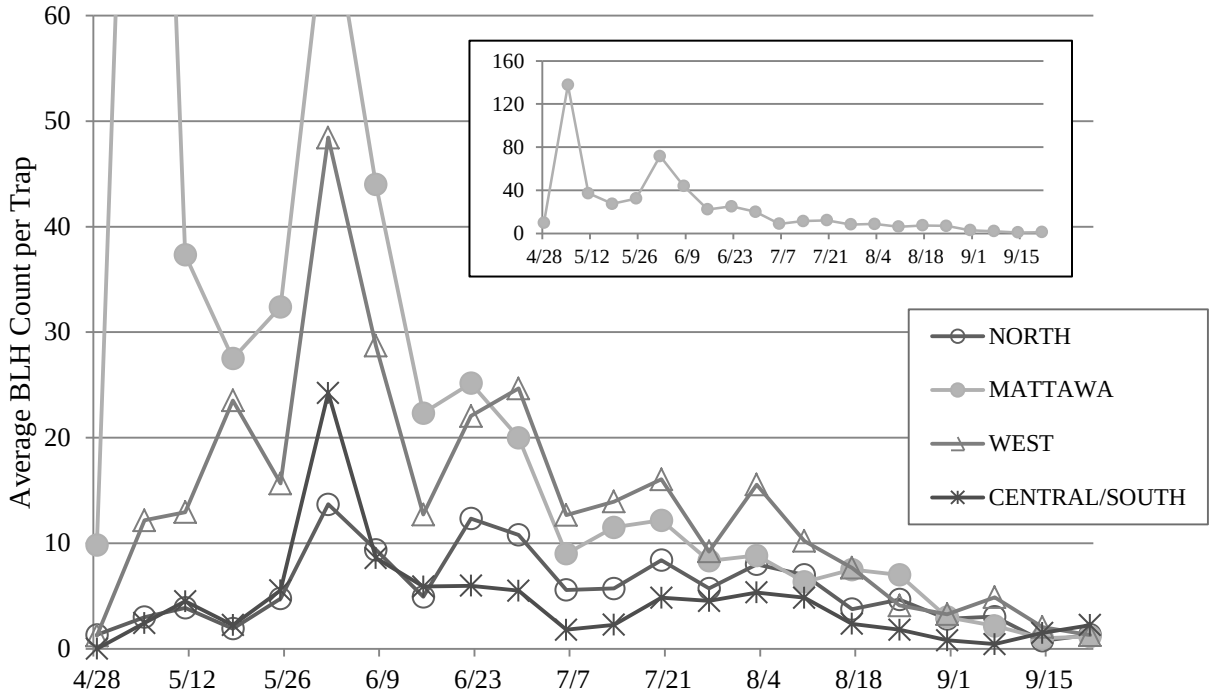


Figure 5. Beet Leafhopper Population Trends in the NORTH Basin
Weekly Trapping Data: 2013 vs. 7-Year Average in the North

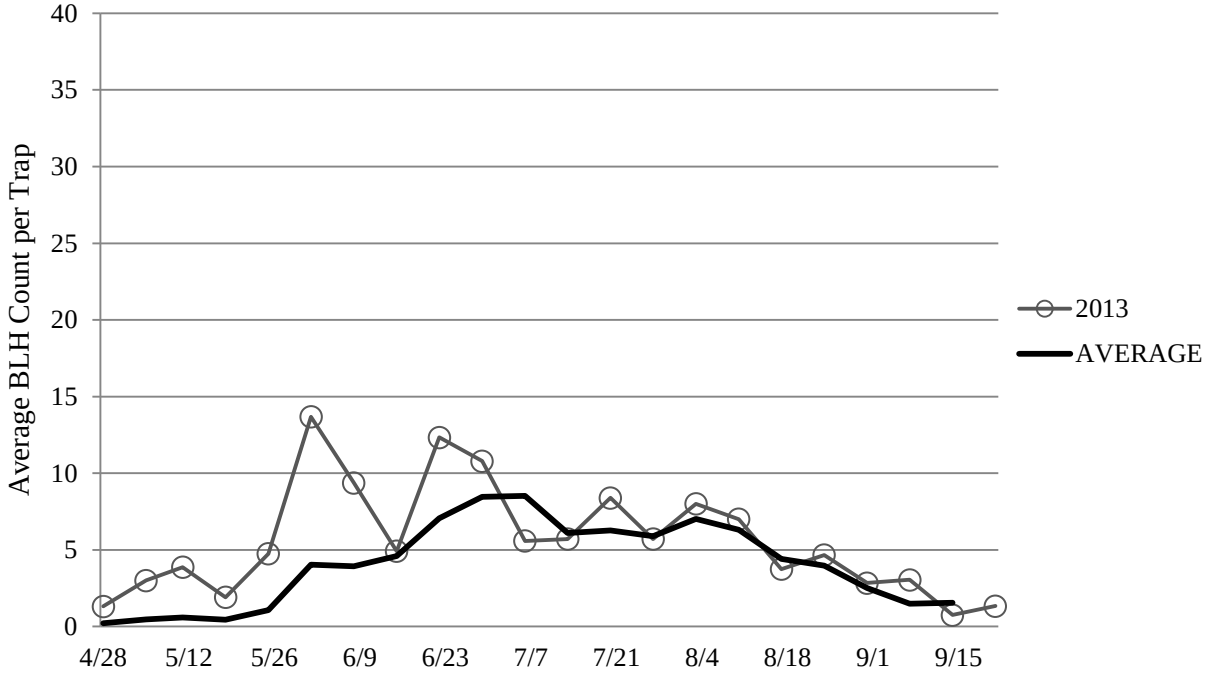


Figure 6. Beet Leafhopper Population Trends in MATTAWA, WA
Weekly Trapping Data: 2013 vs. 6-Year Average for Mattawa

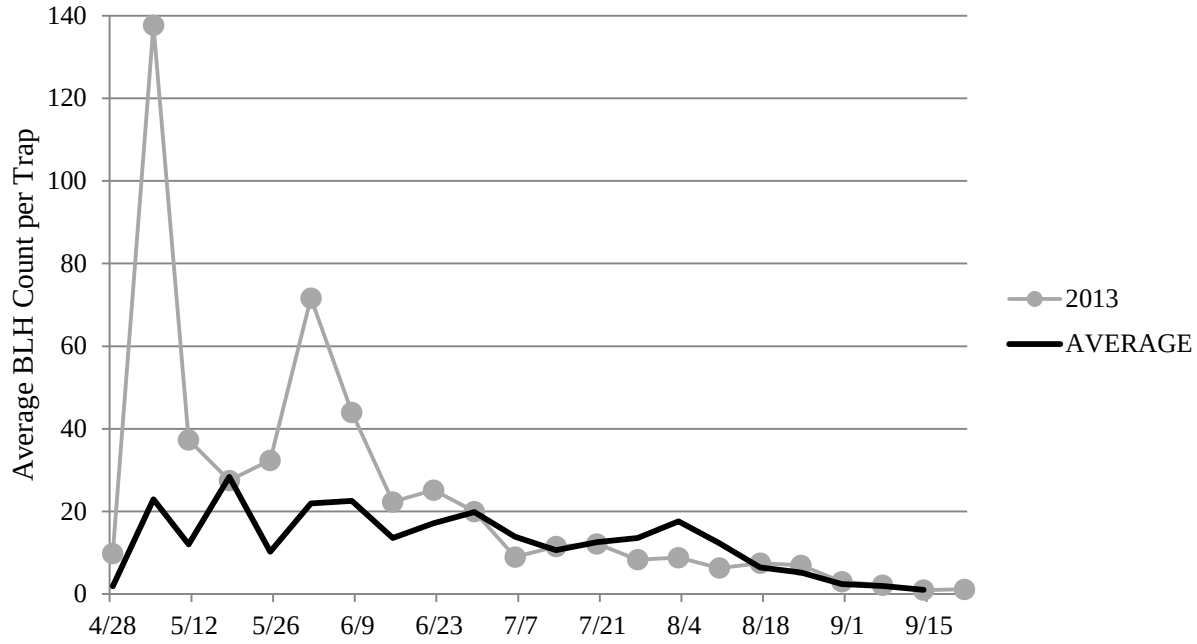


Figure 7. Beet Leafhopper Population Trends in the WEST Basin
Weekly Trapping Data: 2013 vs. 7-Year Average in the West

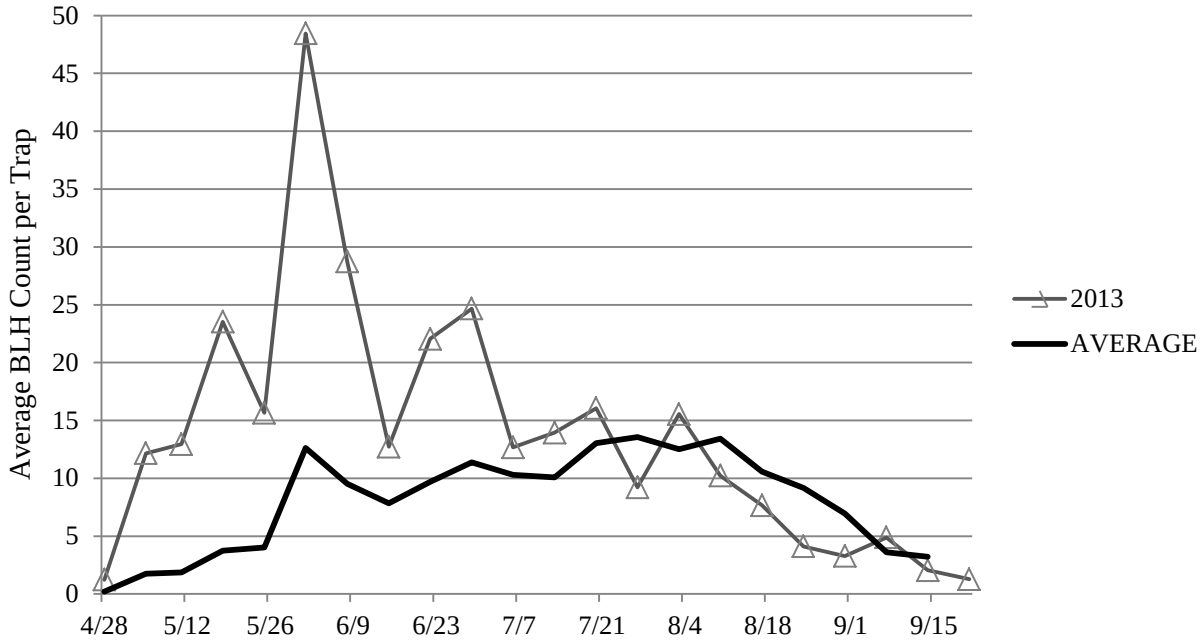
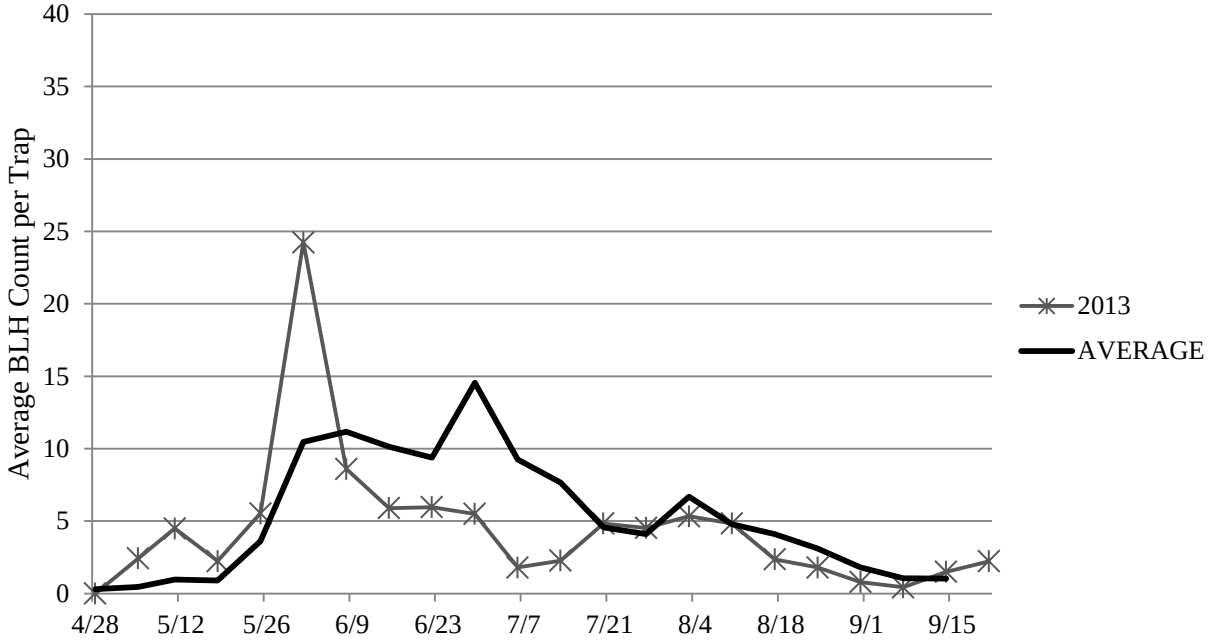


Figure 8. Beet Leafhopper Population Trends in the CENTRAL/SOUTH
Weekly Trapping Data: 2013 vs. 7-Year Average in the Central/South



Potato Tuberworm

Population Trends in Different Areas in the Basin: Potato tuberworm (PTW) populations have been monitored for several years in the Columbia Basin using pheromone traps to attract adult male moths. Figure 9 shows weekly average PTW moth trap counts for different areas in the Columbia Basin; these data are seven-year averages for each area. The graph clearly shows that the vast majority of PTW moths are collected in the Central/South Basin, and very few in the North Basin or West Basin areas. Moreover, the PTW moth trapping network in Northeastern Oregon usually collects even larger weekly average trap counts, compared to the Central/South routes in the Columbia Basin of WA.

General Population Trends: Figure 10 shows the average weekly PTW moth counts for the Central and South Basin routes from 2007-2013, and compares them to the senen-year average. Typically, the PTW moths begin to show up in traps in mid-late June and the numbers slowly increase between July and September. The largest PTW moth counts are usually in late September and early October.

North Basin 2013: The first PTW moth caught in the North Basin in 2013 was on July 16th on a trap near Moses Lake. Over the season, PTW moths were found in traps at 11 of 12 sites in the North Basin, but the counts were always quite small. The most PTW found in a trap in the North Basin was (7) on September 3rd north of Connell. This trap collected (25) moths over the course of the season, the most for the North Basin. The other traps with PTW moths in the North Basin collected only 2-11 moths total for the season.

West Basin (including Mattawa) 2013: In the West Basin, PTW moth were detected at only 4 out of 12 traps sites all season; three were traps near Mattawa, and one was a trap near Quincy. These traps only collected 2-6 PTW moths total for the season.

Central/South Basin 2013: This was a very big year for PTW in the Central/South Basin region. Weekly moth counts climbed significantly between July and August, and the peak population of PTW moths was much larger than in the previous six years (Fig. 10). All traps on the Central and South Basin routes caught PTW moths over the course of the season, but some caught a lot more than others. The most PTW moths found in a trap was (146) on August 19th near the WA/OR border. This trap collected (1,212) moths over the course of the season, which was more than twice as many as at other locations. Other traps in the South/Central Basin collected 2 (near Mesa) to 583 (near Pasco) moths total for the season. Generally, moth counts were highest in fields near the WA/OR border and in fields near Pasco.

Recommendations: Potato tuberworm moth counts were reported in the "potato pest alerts" each week. The alerts sent in late July and August included more detailed guidance about monitoring and managing PTW. The following information was provided on the website… "Potato tuberworm (PTW) was first recognized as an important pest of potatoes in the southern Columbia Basin in 2003. PTW larvae feed on tubers causing damage that renders them unmarketable. Potato growers with fields south of Connell, WA are recommended to pay close attention to regional trapping data, and should deploy pheromone traps. Infestations of PTW are highly localized, and it is risky to conclude too much from traps that may be several miles away. Information about setting up traps and identifying PTW moths can be found in the article, "*Tuberworm Monitoring with Pheromone Traps*". Trap counts from mid-season to harvest are particularly important to watch. Pre-harvest control measures may be warranted in fields where PTW moths in pheromone traps are found to be increasing every week, especially in August-October."

Figure 9. Potato Tuberworm Moth Population Trends in the Columbia Basin
Weekly Trapping Data Frp, Different Areas of the Basin: 7-Year Averages

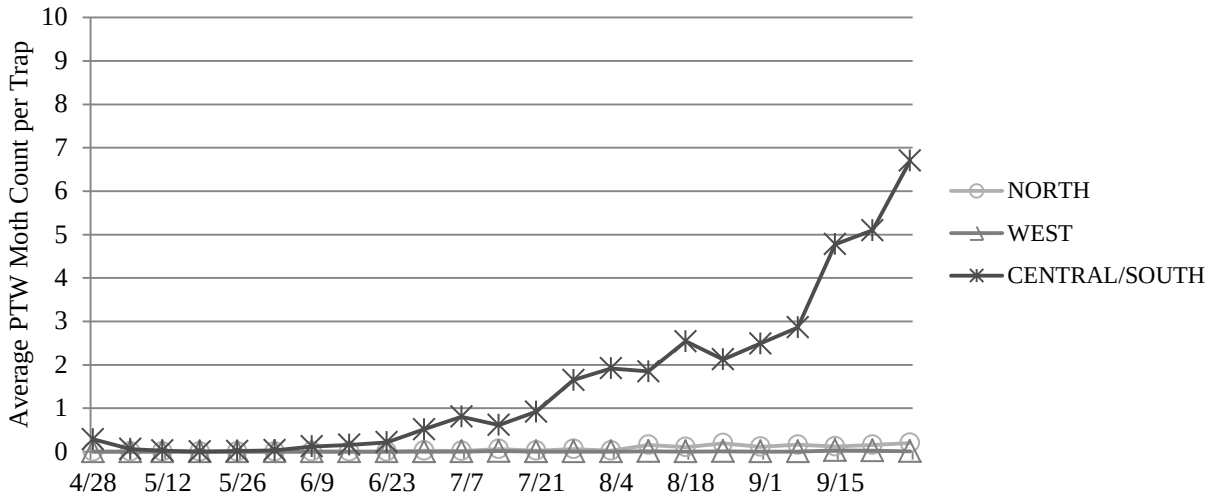
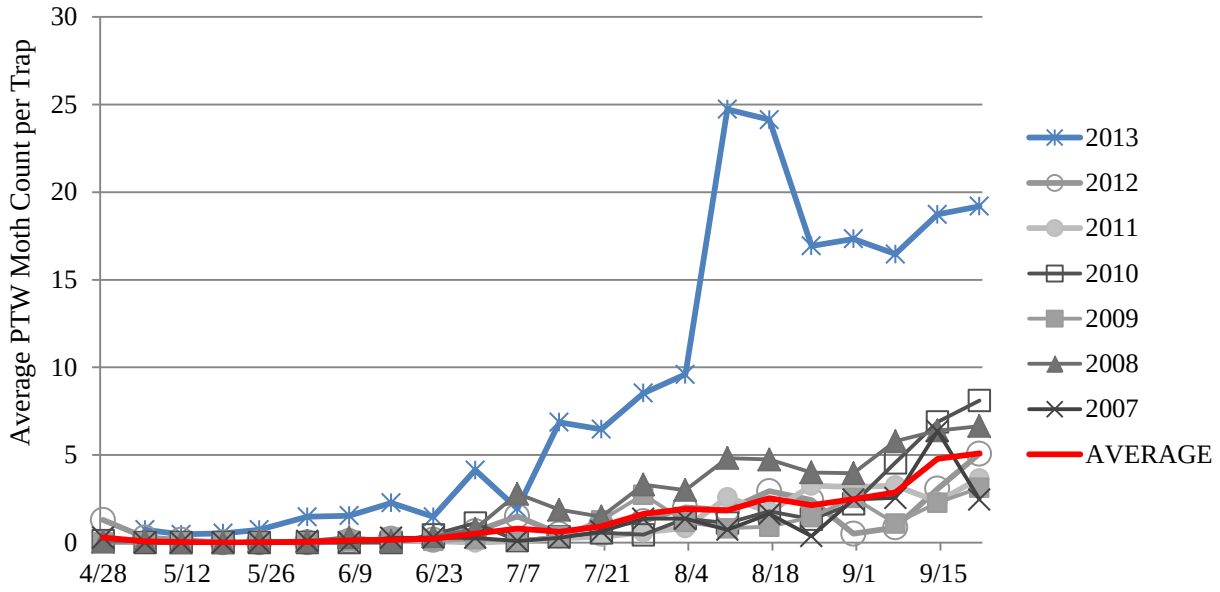


Figure 10. Potato Tuberworm Moth Population Trends in the
CENTRAL/SOUTH Columbia Basin
Weekly Trapping Data: 2007-2013 vs. 7-Year Average



Aphids

General Population Trends: Aphid population trends in the Columbia Basin through the years from 2004 to 2013 are presented in Figure 11. The graph shows the weekly average number of aphids per plant each season (the data are in logarithmic scale because the values range widely). Aphid infestations tended to be larger in the years from 2004-2009. Dr. Keith Pike managed the aphid sampling network in the years prior to 2009, and the current investigators to not have access to individual field data for those years (only weekly averages from grouped fields). However, we do know that it was not uncommon for Dr. Pike to report occasional field infestations in the range of 100-500 aphids per plant. We have access to more detailed information for 2009 and after. In 2009, only a few fields had exceptionally large aphid infestations, i.e. with aphid counts in the range of 50-500 aphids per plant. But, almost one-quarter of the fields had infestations reaching 15-30 aphids per plant in 2009, and the average peak infestation was 30 aphids per plant. In the years since 2009, the largest infestation we observed was 30 aphids per plant at the end of September in 2012. The peak infestations in the years 2010-13 have averaged only 1.5 to 3 aphids per plant. We believe that the reduction in aphid infestation levels in the past four years is due mainly to the recent and widespread use of neonicotinoid insecticides at planting.

The data presented in Figure 11 combines counts of winged and wingless aphids of various species. In general, the aphids we find at the beginning of the season are mostly winged, migratory morphs of several species. We start to find more wingless, colonizing aphids and fewer migratory aphids as the season progresses. By July-August, most of the aphids we collect are wingless, and most of them

are green peach aphids (GPA). At the season end, we start to see migratory aphids again in samples from potato fields.

Population Trends for Winged Aphids in 2013: Our plant sampling methods are not as sensitive for quantifying winged, migratory aphids in potato fields as they are for wingless, colonizing aphids. However, we do collect winged aphids while sampling and record our observations. Figure 12 shows weekly migratory aphid sampling data recorded in 2013; the graph shows both the percentage of fields in which migratory aphids were detected each week, and the average number of aphids per plant in fields that had aphids. Winged, migratory aphids were collected in three fields during the first sampling date, and only a small number were found in each of these fields. We picked up winged aphids in more fields as the season progressed, but the counts continued to be small, and did not increase greatly until August. The largest densities of winged aphids (average of 0.76 aphids per plant) were found in early September when most of the potato fields in the region had dead or mostly senesced vines.

Population Trends for Wingless GPA in 2013: Figure 13 shows the sampling results for wingless, colonizing green peach aphids in 2013; the graph shows both the percentage of fields in which these aphids were detected each week, and the average number of aphids per plant in those fields. Figure 14 is similar to the previous graph and shows the percentage of infested fields each week, but the results are presented for different areas of the Basin. Wingless, colonizing aphids (GPA) were found in two of fields on the first sampling date, but their numbers were very few, only 0.01 aphids per plant (i.e. barely detectable). We continued to find very small numbers of wingless aphids on the Central and South Basin routes through June, but did not start to see them in the North Basin and West Basin until late June and early July (Fig. 14). More fields became infested with GPAs as the season progressed. In mid-August, 59% of the fields we sampled had wingless GPAs with an average density of 0.48 aphids per plant. In late-August, the average number of aphids per plant (in infested fields) exceeded 1.0 per plant. The largest field infestation of GPAs in 2013 was 10.7 aphids per plant on September 2nd in a field near Mattawa. In 2013, eight of the 39 fields (21%) we monitored for aphids exceeded populations of 1.0 or more aphids per plant at some point during the season. The peak infestation level in fields averaged 1.5 aphids per plant.

Recommendations: Aphid counts were reported in all of the "potato pest alerts" in June and thereafter. The following information was provided on the website… "Aphids are important pests because they transmit several important potato viruses, especially potato leafroll virus (PLRV) and potato virus Y (PVY). Green peach aphids are the most important vector of PLRV, which has caused substantial yield and tuber quality losses in the Columbia Basin. PLRV causes net necrosis in some cultivars, an unacceptable tuber defect in processing potatoes. PVY can also result in significant yield losses, and some strains cause tuber defects. Potato growers should monitor fields for aphids at least once a week, because early recognition and control of aphids is the best tactic in limiting spread of potato viruses. Current recommendations are to treat long-season storage potatoes as soon as wingless aphids are detected. Low tolerances have been established because even a low incidence of seed borne PVY and PLRV can spread rapidly if aphids go unchecked."

Figure 11. Aphid Populations in the Columbia Basin
2004-2013 Weekly Potato Field Sampling Data

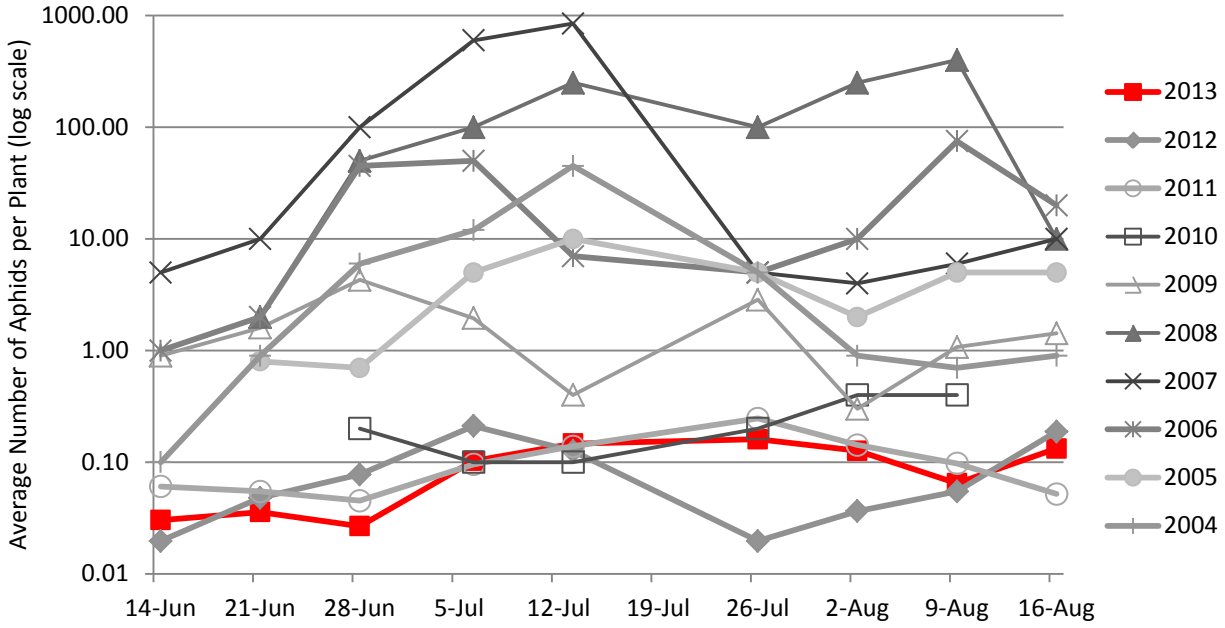


Figure 12. Winged Migratory Aphid Population Trends
Weekly Potato Field Sampling Data: 2013

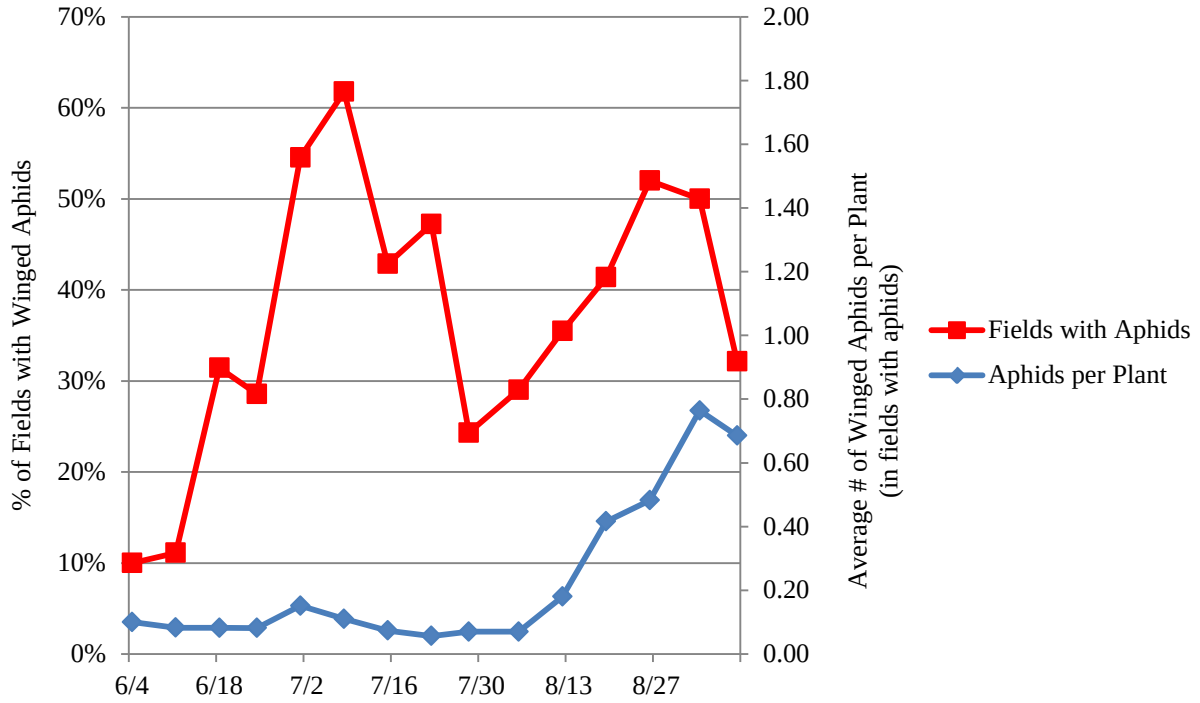


Figure 13. Wingless Green Peach Aphid Population Trends
Weekly Potato Field Sampling Data: 2013

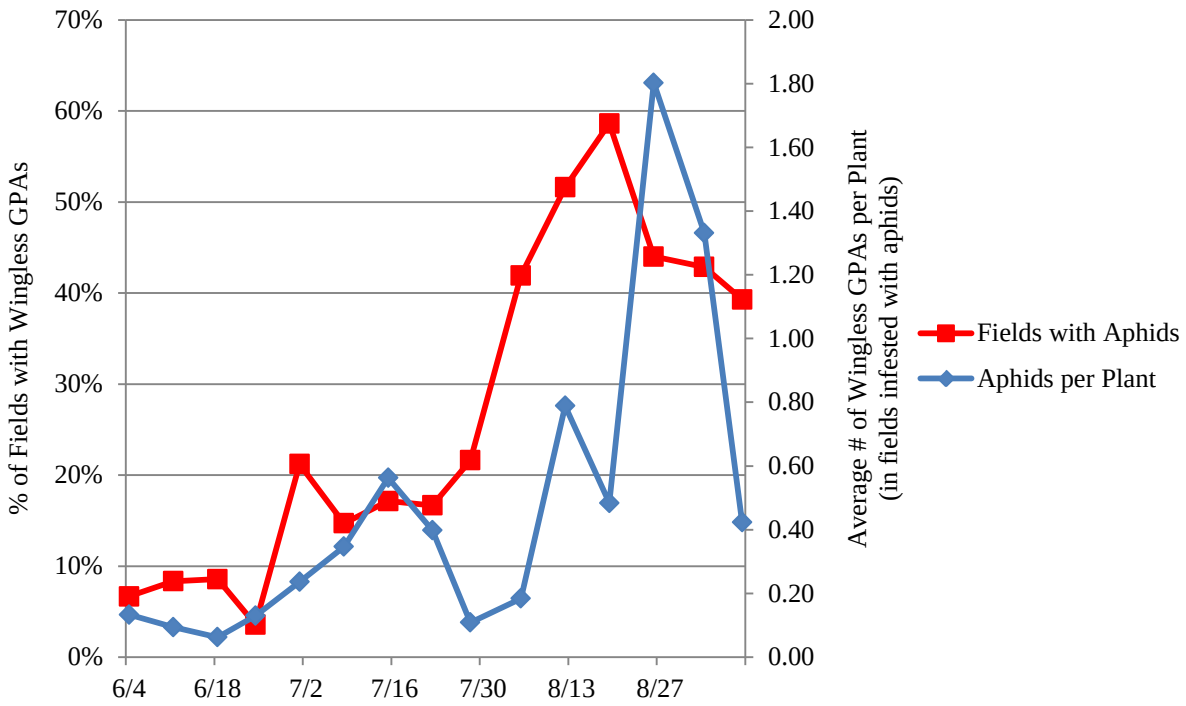
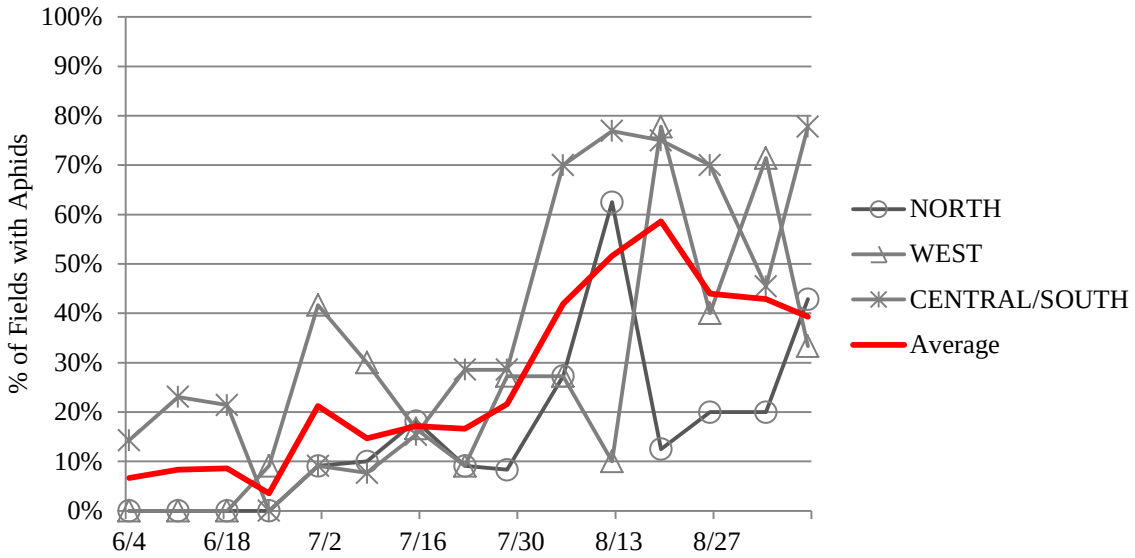


Figure 14. Wingless Green Peach Aphid Population Trends
in Different Parts of the Columbia Basin of WA
Weekly Potato Field Sampling Data: 2013



Potato Psyllids

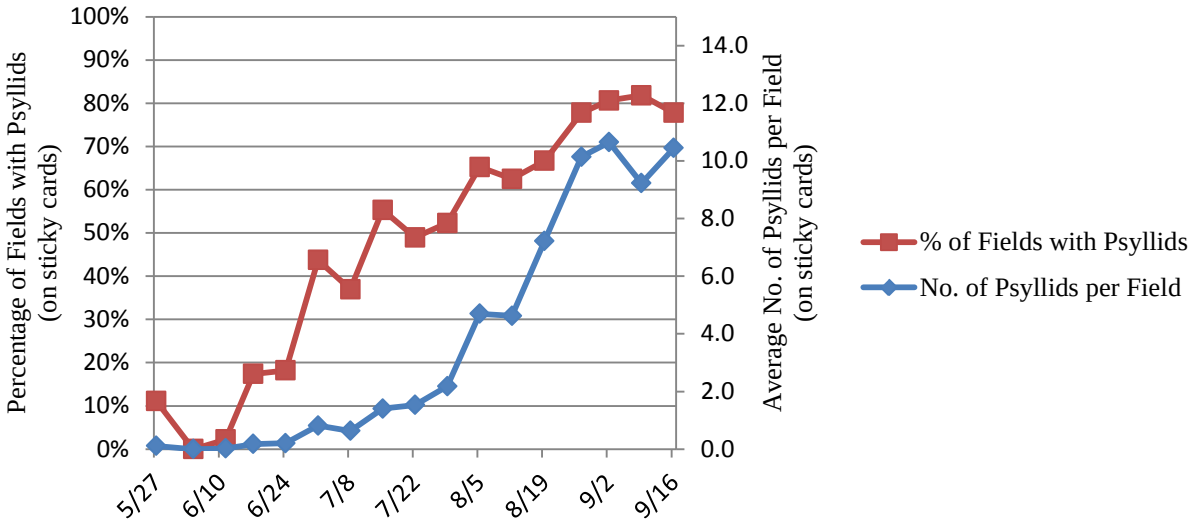
Population Trends: The first potato psyllid collected in the 2013 growing season was on a yellow sticky card deployed for BLH on the corner of a field SW of Othello on May 15. This was not expected, because 1) we did not find any potato psyllids on BLH cards in the previous season, and 2) potato psyllids were not collected in potato fields until June in the previous season. We found several patches of bittersweet nightshade when driving around this field, and suspect that psyllids had overwintered in these patches before moving to the potatoes. However, we did not find any psyllids on the bittersweet nightshade plants we were able to survey (many were difficult approach due to ditches and dense stands of Russian olive trees). We started to deploy sticky cards in potato fields the following week. Figure 15 shows the trapping results for potato psyllids in 2013; the graph shows both the percentage of fields in which adult potato psyllids were detected each week, and the average number of adult psyllids per field on sticky cards. Potato psyllids were found in two fields (10% of fields with sticky cards) the last week of May, and each field had only one psyllid. Both fields were located in the center of the region; one was the field SW of Othello and the other was a field E of Othello. We did not collect psyllids in the South Basin until mid-June. More fields started collecting potato psyllids as the season progressed, and by mid-July we found potato psyllids in 55% of the fields with sticky cards. These fields were distributed across the Columbia Basin, from Plymouth in the south to Wilson Creek in the north. Therefore, by mid-July it can be said that psyllids were flying around in all parts of the Columbia Basin Irrigation Project area. The numbers of potato psyllids found on sticky cards also tended to increase as the season progressed. Many of the largest counts occurred right after the fields had been rolled and/or defoliated, presumably the psyllids were displaced and flying to new locations. By the end of the growing season, we had found at least one potato psyllid in 49 of the 50 fields (including the sentinel plots) with sticky cards. In total, we found 2,012 potato psyllids on yellow sticky cards deployed inside potato fields. On average, we found 40 potato psyllids total for the season on sticky cards in the fields we monitored. The most was 481 potato psyllids for the season in a field E of Kennewick. This contrasts greatly with the results of psyllid trapping in the previous season. In 2012, we found only 12 potato psyllids total for the season in the 39 fields with traps.

Only one of the potato psyllids collected for this project tested positive for Lso (however, we are still waiting on some of the late September results). The “hot” psyllid was collected mid-July in the first field in which we found psyllids for the season; i.e. the potato field SW of Othello. The psyllid was determined to be of the Northwestern haplotype. We monitored this field closely for symptoms of zebra chip. A week later, we found one plant with zebra chip (confirmed by strongly symptomatic tubers with internal necrosis extending through the entire tuber). About one month after finding the “hot” psyllid, we found several plants with symptomatic foliage and mild necrosis in the tubers, but only 2 of 10 plants submitted for testing were actually confirmed to have zebra chip (Dr. Neil Gudmestad confirmed). All of the plants that were submitted had the same visual symptoms, tightly rolled leaves, purple discoloration to leaves, shortened and swollen internodes, and tubers with extremely mild (barely noticeable) internal necrosis.

Recommendations: Information about potato psyllids and sampling results for potato psyllids were provided every week in the “potato pest alerts”. We also made a best effort to provide management recommendations to growers, but it continues to be difficult to accurately assess the risk of damage to crops throughout the Columbia Basin. The following information was provided on the project

webpage… "Potato psyllids are important pests mostly because they can transmit a bacterium (*Candidatus* Liberibacter *solanacearum*) to potatoes that causes zebra chip disease (ZC). This disease reduces both yield and tuber quality and has lead to serious economic losses in some regions. ZC was first detected in potato fields in the Columbia Basin in 2011, and occurred again in 2012. Yellow sticky cards are recommended for detecting psyllid migration into an area. The cards should be placed inside the field, near the field edge, and just above the canopy level. It is best to have five or more yellow sticky cards around the field. Other life stages of the psyllid may be found by collecting several leaves (mid-plant) from the outer rows of the field, and then scanning the underside (with a hand-lens) for the tiny nymphs and eggs. It is also recommended to scout for psyllids in cull piles and volunteer potatoes. For more information about psyllids, including insect identification, monitoring, and control recommendations, read "*Biology and Management of Potato Psyllid in Pacific Northwest Potatoes*" and "*Potato Psyllid Vector of Zebra Chip Disease in the Pacific Northwest*."

Figure 15: Potato Psyllid Migration Trends in the Columbia Basin of WA
Weekly Trapping Results: 2013



PUBLICATIONS & PRESENTATIONS:

Wohleb, C.H. 2013. Development and impact of a sampling network and pest alert system for potato growers in the Columbia Basin of Washington. 97th Annual Meeting of the Potato Association of America.

Wohleb, C.H. 2013. A Sampling Network for Insect Pests of Potato in the Columbia Basin of Washington and "Potato Pest Alerts". 2013 American Society for Horticultural Science Annual Conference. HortScience 48(9):S136. http://www.ashs.org/downloads/2013ASHSAnnualConferenceHS.pdf.

Wohleb, C.H. Development and impact of a sampling network and pest alert system for potato growers in the Columbia Basin of Washington. 97th Annual Meeting of the Potato Association of America. Quebec City, Canada. July 30, 2013.

Wohleb, C.H. A Sampling Network for Insect Pests of Potato in the Columbia Basin of Washington and "Potato Pest Alerts". 2013 American Society for Horticultural Science Annual Conference. Palm Desert, CA. July 23, 2013. *Poster Presentation*.

Wohleb, C.H. Regional Survey for Insect Pests of Potato in the Columbia Basin of Washington. Washington State Potato Commission Research Review, Pasco, WA, February 6, 2013.

Wohleb, C.H. Sampling Network for Insect Pests of Potato. WSU Potato Field Day, Othello, WA, June 27, 2013.

Wohleb, C.H. Overview of the Regional Sampling Network for Potato Insect Pests. McCain's Tour for Visiting Potato Growers of Argentina. Othello, WA. Aug. 7, 2013. *Invited Presentation*.

Wohleb, C.H. Potato Psyllid Update. Bayer Acre Day, Ephrata, WA, July 17, 2013. *Invited Presentation*.

Wohleb, C.H. Regional Sampling Network for Insect Pests of Potato in the Columbia Basin. 6th Annual Basin Producers Pesticide Recertification Day, January 18, 2013. *Invited Presentation*.

Wohleb, C.H. Potato Psyllid and Zebra Chip Disease Update for 2012. Columbia Basin Crop Consultants Association Annual Short Course, January 16, 2013. *Invited Presentation*.

Wohleb, C.H. 2010-present. "Potato Pest Alerts" list serve. Weekly pest and disease alerts e-mailed from April-October to 579 subscribers.